REMARKS

The Examiner's objection to the omission of reference to Claims 1-6 which were withdrawn in response to the restriction requirement has been addressed and corrected.

Claims 11-18 were rejected under 35 U.S.C. §112, second paragraph as being indefinite by reason of the alternative description of the "second operating parameter." In response, the second alternative (the frame rate at which the image frames are to be created) has been deleted from Claim 11. As the Examiner will appreciate, the second operating parameter as defined in the amended claim can lead to computation of the frame rate at which the image frames are to be displayed, should that be needed or required in a particular implementation of the invention. Accordingly it is respectfully submitted that Claim 11 and its dependent Claims 12-18 have been clarified and satisfy the requirements of §112, second paragraph.

Claims 11-18 were rejected under 35 U.S.C. §102(b) as being anticipated by US Pat. 5,976,086 (Matsushima). Amended Claim 11 describes an ultrasound diagnostic imaging system comprising an ultrasound scanhead including an array transducer; an ultrasound transmitter coupled to the array transducer in the scanhead to apply transmit signals to the array transducer; a controller coupled to the transmitter, the controller being operable to trigger the ultrasound transmitter to repetitively apply transmit signals to the array transducer thereby causing the array transducer in the scan head to transmit ultrasound into a region of interest, the controller further receiving a minimum value of a first operating parameter from a user control, the first operating parameter being a minimum acceptable frame rate FR_{MIN} at which the image frames are to be created, the controller further determining a value for a second operating parameter that is different from the first operating parameter based on the

minimum value FR_{MIN} of the first operating parameter, the second operating parameter being the number of transmissions over which the echo signal samples are to be averaged to create the ultrasound image frames; a beamformer coupled to the controller and to the array transducer in the scanhead to receive ultrasound echo signals resulting from each of the transmissions and form the received ultrasound echo signals into beams; a processor coupled to the beamformer, the processor being operable to create ultrasound image frames using the minimum value FR_{MIN} of the first operating parameter and the determined value of the second operating parameter; and a display coupled to the processor, the processor being operable to display an ultrasound image using the created ultrasound image frames. An embodiment of Claim 11 allows the ultrasound system user to select the minimum frame rate he or she will find acceptable. The system then determines whether this minimum can be achieved or enhanced imaging can be done such as sample averaging to reduce noise. Page 6 of the specification gives a typical example of this. In this example, the user may select 10 frames per second as being the minimally acceptable display frame rate. The system may be capable, under the current imaging settings such as depth of field, sector width, and other settings, of an acquisition frame rate of 90 frames per second. The controller will then determine that it can transmit nine image frames which can be averaged to reduce noise and still meet the user's requirement of a display frame rate of 10 frames per second (90 divided by 9 equals ten). To vary the example, suppose the sector width were decreased by the user, enabling an acquisition frame rate of 96 frames per second. The controller could then determine that it could transmit and average 8 acquisition frames to form one display frame, with a resultant display frame rate of 12 frames per second (96 divided by 8 equals twelve). This would provide a high degree of noise reduction and still meet the user's minimum requirement of a frame rate of at least ten

frames per second. The controller thus provides a high degree of noise immunity while still meeting the user's frame rate requirement.

The present invention is directed to frame averaging, whereby a determined number of frames are averaged together. Matsushima is not doing frame averaging, but selective pixel averaging. The time constant for averaging can thus vary from pixel to pixel within an image while the display frame rate remains constant. Thus, for instance, when the heart is being imaged, the tissue defining the chamber in which the heart is contained is relatively stationary, the heart may swing in the chest with each heartbeat, and the heart valves will move very rapidly. The Matsushima approach would then average many pixels of the image area of the heart chamber, a smaller number of pixels of the image area of the myocardium, and few or no pixels of the image area of the heart valves. In order to do pixel-by-pixel averaging, Matsushima uses an IIR filter with an adjustable time constant for each pixel location. The time constant for each IIR filter for each pixel can be set separately to achieve his desired per-pixel averaging. The "thresholds" to which the Examiner refers in column 14, lines 29-62 are explained in column 15, lines 1-56. If a pixel location is only experiencing signal noise, the difference between two successive pixels for the location will be small. But if tissue is moving at the location, the difference can be large as new tissue moves into that pixel location. Thresholding allows Matsushima to distinguish between these two conditions: if the pixel difference is below a predetermined threshold it is treated as noise and more temporal signals are averaged to reduce noise, but if the difference is above the threshold it is considered a motional difference and less signal averaging is performed to reduce blurring by reducing the IIR time constant. There is also a perceptional different which Matsushima is trying to discern. If a pixel location increases rapidly in brightness

(luminance), such change will not be objectionable if it is delayed by a large filter time constant. But if a pixel location decreases rapidly in brightness, the perception may be of excessive and disturbing persistence, that is, a ghosting "after-image." Thus, Matsushima's system is programmed with thresholds which are intended to respond to the direction or polarity of a luminance change at a pixel with different thresholds. Whether this is effective or not will vary with what the user is imaging at any particular moment, of which the system is unknowning. Matsushima makes no mention of any user control and certainly gives no hint of a user control by which the user can set a minimally acceptable frame rate of display. Instead, the Matsushima system is intended to deal with all possible conditions automatically without user input. And since he is operating on each local condition independently, there is no need to be concerned with frame rates. The IIR filters are intended to handle each local dynamic independently without frame rate adjustment. Accordingly it is respectfully submitted that Matsushima cannot anticipate amended Claim 11 or its dependent Claims 12-18.

In view of the foregoing amendments and remarks, it is respectfully submitted that Claims 11-18 as amended cannot be anticipated by Matsushima. Accordingly it is respectfully requested that the rejection of Claims 11-18 under 35 U.S.C. §102(b) be withdrawn.

In light of the foregoing, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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